

SOUTH AFRICAN SEAWEED VEGETATION AND FUTURE INVESTIGATIONS IN THIS FIELD.

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Paper read at the First International Seaweed Symposium, Edinburgh,
July, 1952.

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INTRODUCTION.

Seaweed investigation presents a more complex and varied field in South Africa than in Britain. In the first place the coastline of South Africa is much more extensive and many parts are not easily accessible. Secondly, and still more important, the range of physical conditions is greater due to the influence of two ocean currents. Two other considerations may be mentioned: the seaweed flora is less well known and only scant information is available concerning sub-littoral seaweeds, especially east of Cape Agulhas. This last consideration is important in relation to the examination of drift material since there must often be uncertainty in sorting out what has been thrown up locally from deeper waters and what may have been carried by currents for a longer or shorter distance.

OCEAN CURRENTS AND SEA TEMPERATURE CONDITIONS.

The west coast is subjected to the influence of water of sub-antarctic origin which is referred to as the Benguela Current while the east and south coasts are influenced by the Agulhas Current, a warm water current originating about latitude 11°S. off the coast of East Africa. The Agulhas

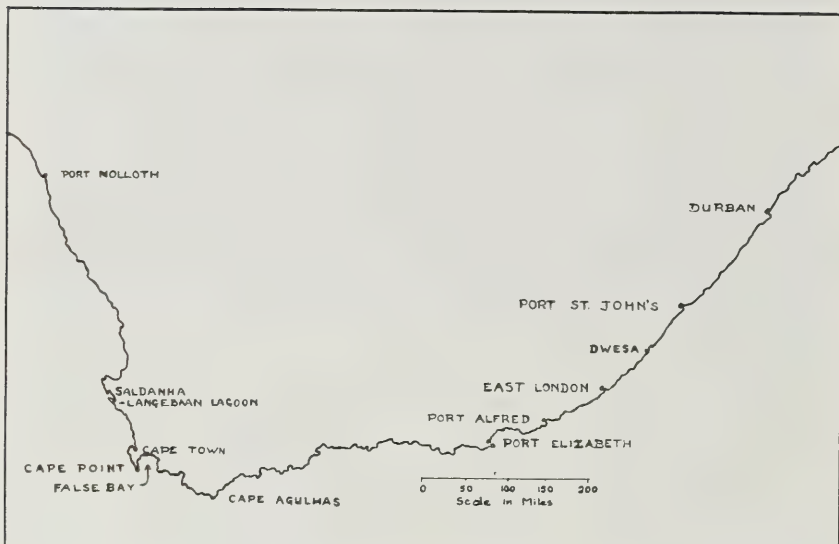


FIG. 1. Outline of Union coastline indicating the chief localities mentioned in the text.

Current flows southwards and westwards until it reaches the Agulhas Bank, which is the only extensive part of the continental shelf around the coasts of Southern Africa. The Agulhas Bank deflects most of the warm water eastwards again but at a higher latitude. Branches of the Agulhas Current, however, move westwards (von Bonde, 1939). Coastal sea temperatures increase in an easterly and northerly direction from Cape Agulhas but they fall in a northerly direction along the west coast of the Union. On the west coast, north of the Union, coastal sea temperatures rise again but even at Walvis Bay just within the tropic of Capricorn, sea temperatures are lower than on the east coast. Thus, the average annual temperature of the sea at Durban (21.8°C) is 5.7°C higher than that of Walvis Bay (16.1°C) although Durban is 7° latitude further south (Isaac, 1937a). Between Cape Agulhas and Cape Point the coastal waters are not directly affected by the ocean currents and temperatures are much affected by local factors such as depth of water and topography especially in relation to the south-east winds of summer. Temperature conditions in False Bay are abnormally high in relation to its geographical position. If we except False Bay, however, the region from Cape Point to Agulhas is best regarded as an extension of the west coast.

For convenience, in the remarks which follow, the coast west of Cape Agulhas¹ has been referred to as the west coast and the coast to the east as the east coast, although it would be more correct to distinguish between the south coast from Agulhas to about Port Elizabeth and the east coast, north of Port Elizabeth. By "cold" or "colder" waters is meant the waters off the west coast as defined above but excluding False Bay and "warm" or "warmer" waters refer to the seas east of Cape Agulhas. The terms "warm" or "warmer" waters are also applicable to the waters of the northern part of False Bay. Clearly such terms in reference to sea temperatures are relative; this is especially the case with regard to "cold" waters (Isaac, 1951).

It is inevitable that the existence of contrasting east and west coast sea temperature gradients will result in at least two groups of seaweed floras and vegetation. The contrasts and changes do not present a simple picture since there is overlapping in distribution of the flora and vegetation characteristics between one part of the coast and the next. This results from the fact that species differ in the temperature ranges under which they flourish and in their tolerance to temperatures under which they may occur. In this connection it is well to remember that there is no direct relationship between the range of temperature tolerance and the extent of coastal distribution expressed in miles. A species occurring in a region of relatively rapid temperature change may show a wider temperature tolerance than a species distributed over a longer length of coastline where temperature changes are more gradual. The temperature data available indicate that in general a stretch of west coast will show less temperature change than a corresponding stretch of east coast.

GENERAL CHARACTERISTICS OF THE SEAWEED VEGETATION AND FLORA OF SOUTH AFRICAN COASTS.

In spite of the contrast which exists between the seaweed flora and vegetation of the east and west coasts, the South African seaweed vegetation and flora have a few general characteristics.

A first general characteristic is the relatively limited vertical extent of the inter-tidal seaweed vegetation. This is due chiefly to the limited tidal range and to the paucity of algal growth at higher inter-tidal levels which is in turn associated, at least to some extent, with the climatic conditions of the land (Isaac, 1938). Along the coasts of South Africa the tidal range from low water to high water spring tides varies from about 5 to 6 feet (Bauer, 1933; Admiralty charts). Except locally little

¹ Cape Agulhas is the most southerly point of the African continent.

or no emersed algal vegetation occurs above high water level of neap tides. On the west coast the prominent alga at and some distance below high water neaps is *Porphyra capensis*. This species is found from Port Nolloth (Bright, 1938) to Port St. Johns but east of Agulhas it becomes very sporadic in distribution, smaller in size, paler in colour and forms less dense and much smaller communities than on the west coast. On the west coast it frequently forms a dense, more or less continuous girdle² persisting throughout the year while at Port St. Johns an hour's search may yield only a few individuals. The dense and extensive *Porphyra* communities of the west coast are not replaced by other corresponding communities on the east coast which thus presents an impression of even more limited inter-tidal seaweed vegetation. Locally, especially where spray is hurled upwards by rough seas, small pale plants of *Porphyra* occur above high water of neap tides and even above high water level of spring tides. Again, in damp shaded places a dense growth of various other algae especially *Bostrychia* occurs at high inter-tidal levels. Such occurrences tend, however, to emphasise the general barrenness above high water neap tides on the west coast, and east of Agulhas the general barrenness above about mid-tide level. In rock pools, especially where fresh water runs into the sea, *Ulva* and particularly *Enteromorpha* spp. may be prominent above high water neaps.

A second general characteristic of the inter-tidal algal vegetation of South African coasts is the predominance of Rhodophyceae. As far back as 1893 Murray had drawn attention to the relative richness of species of Rhodophyceae in the seaweed flora of South Africa. Few of the South African inter-tidal Rhodophyceae are a bright red colour although such are not lacking, e.g. *Plocamium corallorhiza*. The prominent warm water species *Hypnea spicifera* and the much less common *H. viridis* are usually bright green while the common west coast *Aeodes orbitosa* is usually brown. Other species (*Gigartina radula*, *G. stiriata*, cold water *Porphyra capensis*) are usually dark, almost blackish-red. The Rhodophyceae, however, over the greater extent of the coast dominate the vegetation at every inter-tidal level. Unlike the coasts of Western Europe, the Fucales are not a prominent feature of the vegetation. The outstanding exception in this respect is *Bifurcaria brassicaeformis* which dominates a lower inter-tidal level from Cape Town to Cape Agulhas (Isaac, 1951). *Sargassum longifolium* is locally common or even, very locally, dominant, in the upper sub-littoral and lowermost littoral levels between Cape Point and Cape Agulhas (Isaac, 1947) and at Dwesa on the Transkei coast. Other species of *Sargassum* are common in the

² The term "girdle" as recommended by Feldmann (1951, p. 321) is used here instead of "zone".

warmer waters east of Agulhas but these plants do not dominate inter-tidal girdles although locally they may form clans of emersed plants as well as sometimes being common in the upper sub-littoral and in rock pools, the vegetation of which they sometimes dominate. Another member of the Fucales, *Carpophyllum scalare* is abundant or dominant very locally at Port Alfred and at Dwesa. In warm waters, members of the *Caulerpaceae* may dominate the vegetation or cover areas to the exclusion of other plants in shallow sea or at low inter-tidal levels. This is the case with *Caulerpa filiformis* in shallow water, usually in sand, in places at Port Alfred (The Kowie) and to a lesser extent in localities from East London to Port St. Johns, as well as in places on the north-west coast of False Bay (part of the St. James coast); and at lower inter-tidal levels *Caulerpa racemosa* var. *zeyheri* occurs in moderately sheltered places where there is swell, for example at Port Alfred, East London and Port St. Johns. Still, such occurrences as we have cited can be regarded as local intrusions into levels which are chiefly dominated by Rhodophyceae along the entire length of the coastline of the Union of South Africa.

Brief attention may here be called to those ubiquitous genera *Ulva* and *Enteromorpha*. The distribution of these plants is largely related to salinity variations and they flourish under conditions of both low and high salinity. Thus along the coastline of the Union *Ulva lactuca* and species of *Enteromorpha* occur in rock pools high in the inter-tidal area as well as in places where there is a mingling of fresh and salt water. Plants of these genera also occur in places where they remain emersed by the falling tide although they rarely show signs of drying out since they occur in habitats where there is spray or where water is retained due to the presence of numerous small depressions of the rock surface. Of the emersed *Ulva*, *U. lactuca* is more characteristic of cold waters, *U. rigida* flourishes characteristically east of Cape Agulhas, and *U. minuta* is characteristic of warm waters. The emersed micro-species of *Enteromorpha* are a feature of the warmer waters.

THE MARINE ALGAE OF THE WEST COAST.

The contrast between the seaweed vegetation of the west coast north of Cape Town and of the east coast north of Port Elizabeth is obvious and striking but the contrast is less marked for the region between Cape Agulhas and Port Elizabeth (South Coast) and either the west coast or the east coast north of Port Elizabeth. Clearly the region east of Agulhas needs to be subdivided, but before this can be done satisfactorily more data are needed for the stretch of coast between Agulhas and Port Elizabeth. The west coast can be subdivided into two:—

I. Port Nolloth to Cape Town.

II. Cape Town to Cape Agulhas but excluding False Bay.

Locally, conditions may deviate to a considerable extent from the conditions prevailing in neighbouring districts. This is pre-eminently the case with False Bay which needs to be considered on its own. It is also the case with the Saldanha Langebaan lagoon.

The most obvious characteristic of the west coast is the presence of an extensive sub-littoral growth of kelps (Isaac, 1937*b*, 1938, 1942). These beds extend to depths of at least 25 to 30 feet since the stipes of the largest species, *Ecklonia maxima* attain these lengths. The fronds and sporophylls of *Ecklonia* toss about at the surface of the water. *Laminaria pallida* is a second common species of kelp. *Laminaria* is a smaller plant than *Ecklonia* and it lacks a float and hollow stipe which are found in the latter but it may well extend into deeper waters. Precise data on this matter are lacking. A third west coast kelp is a species of *Macrocystis* which in the past has been named *M. pyrifera*; the specific identity of this plant, however, is somewhat uncertain.³ The kelps are typically sub-littoral plants but in places they occur at the lower inter-tidal levels. *Macrocystis* is much less abundant than the other two species, being confined to a limited stretch of the southern part of the west coast north of Cape Point but locally it may be abundant. It occurs in situations sheltered from the full force of the sea, as in quiet bays or within a palisade of *Ecklonia* (Isaac, 1937*b*). *Laminaria pallida* is more typically a cold water species than *Ecklonia maxima*. The former kelp is at best a rare species east of the Cape Peninsula⁴ and becomes relatively more abundant in a northward direction along the west coast. *Ecklonia* occurs from Port Nolloth (Bright, 1938) to Cape Agulhas and it is a prominent plant over the greater part of this range. At its eastern limits it is a relatively small plant and not abundant. In many localities large quantities of kelp are thrown up on the shore and accumulate above tide level.

A second outstanding characteristic of the west coast is the presence of a girdle of *Porphyra capensis* extending downwards from high water neaps. The growth of *Porphyra* is often dense, *P. capensis* forming almost pure communities. On the west coast the plants are large, of a dark purplish red colour and the *Porphyra capensis* community (association) remains without essential change throughout the year (Isaac, 1937*b*; 1942).

Taken as a whole the common and characteristic cold water species are relatively large; such are *Champia lumbricalis* and *Aeodes orbitosa*. Other large plants found in cold water are *Gigartina radula*, *G. stiriata*

³ A paper on South African *Macrocystis* is in course of preparation.

⁴ Unless it is common in deeper water so as not to be visible at the surface.

and *Codium fragile*. *Splachnidium rugosum* is a larger plant and more abundant on the west coast than in the warmer waters east of Agulhas. Small species are also found, e.g. *Caulacanthus ustulatus*, which is widely distributed in cold and warm waters.

The outstanding difference between the west coast north of Cape Town and the part from Cape Town to Cape Agulhas is that the "fucoid" species *Bifurcaria brassicaeformis* is a prominent species of the latter where it dominates a girdle in the lower part of the inter-tidal region. It forms dense communities (associations) to the practical exclusion of other plants (Isaac, 1951). Over the greater part of this sub-region *Gelidium pristoides* also occurs.

THE MARINE ALGAE OF THE EAST COAST.

The east coast seaweed vegetation presents a marked contrast to that of the west coast in three outstanding respects:—

- (1) The absence of large sub-littoral algae reaching the surface of the water.
- (2) The absence of a *Porphyra* girdle although, as indicated earlier, *P. capensis* extends at least as far north-eastwards as Port St. Johns.
- (3) The seaweeds are in general of smaller size than those of the cold waters and dense mat-like or sward-like mixed communities of small algae are a prominent feature.

As a result of these characteristics the coasts of the warmer seas have a much more barren appearance than those of the colder seas at high water of all tides and at low water of neap tides. At low water of spring tides, however, a great and varied wealth of algal growth is seen.

Although the large kelps are absent east of Cape Agulhas, two species of *Ecklonia* are found in warmer waters: *E. richardiana* and *E. biruncinata*. These plants are most typical of the central part of the warm water region and *E. biruncinata* is seemingly far more abundant than *E. richardiana* but further study of the warm water Ecklonias is needed. *E. biruncinata* is dominant in places at Port Alfred and East London and shows a very luxuriant growth at Dwesa where over most of the coast it dominates the uppermost sub-littoral. As compared with the cold water kelps, the warm water Ecklonias are small plants usually not exceeding 4 feet in length inclusive of stipe and frond. Since these plants are relatively short the warm-water *Ecklonia* girdle is relatively narrow as seen at the surface of the sea and thus is never such a spectacular sight as may be presented by the kelp association of cold waters.

While there is a smaller bulk of algal tissue between tide levels in warmer as compared with colder waters, the flora is richer in species.

The increase in the number of species becomes more marked and tropical elements more pronounced in a north eastward direction from Cape Agulhas, these changes being correlated with a gradient of increasing sea temperatures.

Of the warm water species, *Hypnea spicifera* is a widespread dominant plant at the lowest inter-tidal levels. The species is dealt with in a separate paper (Isaac and Hewitt, 1953). *Gelidium pristoides* and *G. reptans* are also worthy of note. The former is essentially characteristic of moderately warm waters but is distributed from the central west coast (Kommetje) of the Cape Peninsula to about 60 miles north of Port St. Johns. *G. reptans* extends further into warmer waters (Stephenson, 1947). These species are found at mid-tidal levels. At the lowest tidal levels we find *Gelidium cartilagineum* and the smaller, slenderer but somewhat similar *G. rigidum*.

From the floristic point of view the warmer seas are characterised by a greater wealth of littoral Chlorophyceae and Phaeophyceae than the colder seas. The characteristic Chlorophyceae belong especially to the Siphonales and Siphonocladiales. Among the former are a number of species of *Caulerpa*, *C. filiformis* and varieties of *C. racemosa* being frequently very abundant. Mention may also be made of *Halimeda cuneata*, *Pseudocodium de-vriesii* and several species of *Codium*. Among the Siphonocladiales are those strange algae, *Valonia aegagropila* and *V. macrophysa*. Prominent among the Phaeophyceae are *Sargassum* spp. and Dictyotales. *Sargassum longifolium* is exceptional in that it flourishes in places between Cape Point and Cape Agulhas in which localities it grows intermingled with *Ecklonia maxima* (Isaac, 1947). Of the Dictyotales, *Dictyopteris*, *Zonaria tournefortii* and *Padina* spp. including *P. comersonii* may be listed; all plants found exclusively in warmer waters. The following are some of the Rhodophyceae known only well within the warm water region: *Hypnea viridis*⁵, *Dictymenia stephensonii*, *Corallopsis aculeata*, and *Mesotrema elegans*.

It should be realised that the species named in the foregoing account by no means exhaust even the common algae of the South African coast as no more has been attempted than a general sketch of the most outstanding features of the algal life of South African coasts.

FUTURE INVESTIGATIONS.

The early history of the study of South African seaweeds will be published elsewhere and it will be sufficient for our present purpose to

⁵ Range given by Papenfuss (Papenfuss, 1947) is Natal coast. It was found by the writer growing on the Pondoland coast (Port St. Johns, Mpandi) and on the Transkei coast at Dwesa.

draw attention to the fact that until the early thirties only a little work had been done in this field. From the early thirties onwards there was an increase in the bulk and scope of the work published. This work has included ecological studies, life history investigations and taxonomic work. Much of the taxonomic work has been concerned with corrections of previous errors in nomenclature without any change in the delimitation of the species concerned but a number of new species have also been described. Kylin, Levring, Mantza and especially Papenfuss have been active in this work.

As a result of the ecological work of Stephenson and his co-workers, who dealt with algae as well as with animal species, and of Isaac, a general picture is available of the geographical distribution of at least most of the chief algal species and of the main features of the seaweed ecology of South African coasts. Further information is needed to complete and clarify this general picture. Thus more studies of particular localities are needed as well as of the algal ecology of the coast between Cape Agulhas and Port Elizabeth. Also, even in terms of a general picture, certain published accounts need amplification and correction, as for example the account given of the algae of Port Elizabeth by Stephenson, Stephenson and Bright (1938). Detailed ecological investigations of particular localities, however, would possibly be more profitably postponed until more taxonomic work has been done. The need of critical taxonomic investigation of certain genera and groups of genera is apparent to investigators of South African seaweed ecology. This applies especially to the algae of warm waters. The conduct of seaweed investigations would be greatly facilitated by the publication of a flora. The time is possibly not ripe for the publication of such a work but the publication of a provisional flora would prove a great boon. Meanwhile there is considerable scope for detailed work on the ecology and physiological ecology of common species and groups of species as well as for preliminary investigations of the floras and ecology of rock pools and of the sub-littoral. The need of further work relating to the general algal ecology of South African shores has been indicated above.

In relation to the autecology of common species, it may be pointed out that little or nothing is known on many matters of importance relating to the exploitation of South African seaweeds for industrial and commercial purposes. Information is much needed on the following matters:—

(1) *Estimation of the absolute growth density of individual species in sample areas; density to be expressed in terms of fresh and dry weights per unit area.*

(2) *The extent to which perennial species can be cut back and regenerate and studies of the rate of regeneration.*

(3) *The rate of re-colonisation by algal species following the clearing of sample rock surfaces.*

One study bearing on this subject has already been published (Bokenham and Stephenson, 1938).

(4) *Seasonal reproductive cycles.*

Work on item (4) is especially urgent in view of possible commercial exploitation. The investigation of seasonal reproductive cycles involves collection and sorting of adequate samples of a species at regular intervals throughout the year for a few years. It also involves the examination of samples from a number of localities, especially in the case of those species which show a relatively wide tolerance of changes in habitat conditions. Such work will be chiefly directed, in so far as harvesting is concerned, to determining whether there are months of the year during which the plants should not be collected. Provisional advice for a given species might be given after one or two years' investigation but more certain information will involve work extending over longer periods. With such species as those of the Laminariales and Fucales the problem is relatively simple since what is involved is periodic determination of the proportion of fertile and non-fertile diploid individuals, since the haploid individuals are microscopic and not collected (Laminariales) or absent (Fucales). With the majority of Rhodophyceae, however, sorting of samples into non-fertile, male, female and tetrasporic plants is involved. As these phases of a single species are usually all morphologically similar a much more complex problem is involved.

(5) *Seasonal changes of vegetative parts of perennial species.*

This includes for a given species assessment of periods of relative dormancy and of active growth or the establishment of the fact that growth is more or less uniform throughout the year. It also includes a determination of the extent to which an increase in tissue in a particular species is due to the formation of new plants by sexual or asexual reproduction and to what extent it is due to vegetative increase of existing plants. For example, to what extent is the dense growth of the *Hypnea spicifera* and *Bifucaria brassicaeformis* associations due to the vegetative growth of new fronds from the creeping rhizomes? The answer to this question will clearly have a bearing on action to be taken in relation to seasonal reproductive cycles.

The information obtained in relation to the exploitation of species of economic importance is necessary if exploitation is to be based on a sound conservation basis. In this connection, however, it is fair to point out that in the case of a few species (e.g., *Ecklonia maxima* and *Gracilaria*

confervoides) exploitation can proceed far by making use of cast up weed. This, however, is not the case with such species as *Gelidium pristoides*, *Gigartina radula*, *Acodes orbitosa*, *Hypnea spicifera* and *Porphyra capensis*, to name some of the species of actual or potential economic importance.

The information obtained from such studies will be of ecological importance as well as of economic importance. Autecological information, however, is needed for a wider range of species both perennial and annual. For the warmer waters especially, it is necessary to follow out the times of disappearance of certain species as well as of changes in relative abundance and any changes that there might be in inter-tidal level.

(6) *Seasonal changes in the amounts of the chief organic compounds present.*

This information will be of value to the biochemist and physiologist as well as to the industrialist.

From these remarks it will be clear that while a general picture of seaweed distribution on South African coasts is now available much work remains to be done. While further detailed work in certain directions is held up until further taxonomic investigations are completed, the autecology of the common species and preliminary ecological work on hitherto neglected aspects present fruitful fields for investigation.

SUMMARY.

The study of South African seaweed vegetation is complex due to the extensive coastline, the range of sea temperatures, and the imperfectly studied algal flora.

Along most of the coast the coastal waters are affected by one of two ocean currents; the cold Benguela Current moving northwards along the west coast and the warm Agulhas Current moving southwards and westwards along the east and south coasts as far as Cape Agulhas, the most southerly point of Africa. Between Agulhas and Cape Point sea temperatures are affected by branches of the Agulhas Current, coastal topography and prevailing winds. False Bay has abnormally high temperatures for its geographical position and its algal flora and vegetation must be considered separately. For convenience in a general account, the coasts west and east of Agulhas are called west and east coast respectively. The seaweed flora and vegetation of east and west coasts show marked contrasts although there is overlap, especially at their southern limits. Changes are also evident along each coastline in relation to sea temperature gradients.

Certain features are common to both coasts. (a) Limited vertical extent of inter-tidal vegetation due to narrow tidal range (low water springs to high water springs, 5—6 ft.) and paucity of algal growth at

higher inter-tidal levels. Algae are mostly absent above high water neaps on west coast and above mid-tide level on east coast. (b) Over most of the coast Rhodophyceae dominate every inter-tidal level. Outstanding exceptions are the dominance at a lower inter-tidal level of *Bifurcaria brassicaeformis* from Cape Town to Cape Agulhas and the local dominance of Caulerpaceae in warm waters.

The west coast is characterised by extensive sub-littoral growths of large kelps—*Ecklonia maxima*, *Laminaria pallida* and to a much smaller extent, *Macrocystis*, and by a girdle, frequently dense, of *Porphyra capensis* extending downwards from high water neaps. East coast species of *Ecklonia* are small and much less abundant. A *Porphyra* girdle is absent although small, pale plants of *P. capensis* occur as far north on the east coast as Port St. Johns. East coast seaweeds are mostly smaller and dense mixed communities of small algae are common. The flora is richer and many species are confined to warmer seas.

Future investigations are considered, bearing in mind information needed for seaweed exploitation on a conservation basis. While detailed investigation is held up in certain directions until further taxonomic work is completed, preliminary ecological work on previously neglected aspects and the autecology of common species present fruitful fields of investigation.

ACKNOWLEDGEMENT.

Some of the observations included in this paper were made while the author was doing field work financed by the South African Council for Scientific and Industrial Research.

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TAXONOMIC NOTES.

Chlorophyceae.

Ulva minuta Papenfuss, ined. Papenfuss' authenticated material (L. 131) in Botany Department, University of Cape Town.

Phaeophyceae.

Ecklonia biruncinata (Bory) Papenfuss. This plant was known earlier as *E. radiata* (Turn.) J. Ag. Papenfuss (1940) later published the view that the plant should be named *E. exasperata* (Turn.) J. Ag.; being regarded as a distinct species and not as a variety of *E. radiata*. Still later (Papenfuss, 1944), this species was renamed *E. biruncinata* (Bory) Papenfuss since the plant was first described as *Laminaria biruncinata* by Bory in 1826.

Ecklonia richardiana J. Ag. Stephenson (1947) regards the South African plants named *E. richardiana* by Papenfuss (1940a) as probably variants of *E. biruncinata* but he gives no reasons for his view.

Rhodophyceae.

Aeodes orbitosa (Suhr) Schm. In earlier papers the name *Iridaea capensis* was used to cover both *Aeodes orbitosa* and *Iridophycus capensis*.

Gelidium rigidum (Vahl) Grev. There is some doubt as to whether the plant known by this name in South Africa is not *G. amansii* (Lamour) Lamour.

Gigartina stiriata (Turn.) Aresch. This includes the tetrasporic plant which is morphologically distinct and was formerly known as *G. burmanii* (Mert.) J. Ag.

CHANGES IN NOMENCLATURE.

Chlorophyceae.

Caulerpa filiformis (Suhr.) Hering; *C. ligulata* Harv. ex J. Ag. (Papenfuss, 1940a).

Phaeophyceae.

Ecklonia maxima (Osbeck) Papenf.; *E. buccinalis* (L.) Hornem. (Papenfuss, 1940b).

Styopodium zonale (Lamour.) Papenf.; *S. lobatum* (Ag) Kütz. (Papenfuss, 1940a).

Rhodophyceae.

Martensia elegans Hering; *Mesotrema elegans* (Her.) Papenf. (Papenfuss, 1942).

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